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RESEARCH ARTICLE

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Contribution to the floristic knowledge of the head of the Po Valley (Piedmont, north Italy)

Daniela Bouvet[1], Annalaura Pistarino[2], Adriano Soldano[3], Enrico Banfi[4], Massimo Barbo[5], Fabrizio Bartolucci[6,7], Maurizio Bovio[8], Laura Cancellieri[9], Fabio Conti[6,7], Romeo Di Pietro[10], Francesco Faraoni[11], Simonetta Fascetti[12], Gabriele Galasso[4], Carmen Gangale[13], Edda Lattanzi[14], Simonetta Peccenini[15], Enrico Vito Perrino[16], Roberto Rizzieri Masin[17], Vito Antonio Romano[12], Leonardo Rosati[13], Giovanni Salerno[18], Adriano Stinca[19,20], Agnese Tilia[21], Dimitar Uzunov[22]

1 *Department of Life Sciences and Systems Biology, University of Turin, Viale P.A. Mattioli 25, 10125 Turin, Italy* **2** *Regional Museum of Natural Sciences, Via G. Giolitti 36, 10123 Turin, Italy* **3** *Largo Brigata Cagliari 6, 13100 Vercelli, Italy* **4** *Museum of Natural History, Botanical Department, Corso Venezia 55, 20121 Milan, Italy* **5** *Via V. Alfieri 10, 33100 Udine, Italy* **6** *School of Biosciences and Veterinary Medicine, University of Camerino, Italy* **7** *Apennines Floristic Research Center, San Colombo, Via Prov.le Km 4,2, 67021 Barisciano (L'Aquila), Italy* **8** *Via Saint Martin de Corléans 151, 11100 Aosta, Italy* **9** *Department of Agriculture and Forestry Science, Tuscia University, Via San Camillo de Lellis, 01100 Viterbo, Italy* **10** *Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Via Flaminia 72, 00196 Rome, Italy* **11** *Via Rubattino 6, 00153 Rome, Italy* **12** *School of Agricultural, Forestry, Food and Environmental Sciences, Basilicata University, Via Ateneo Lucano 10, 85100 Potenza, Italy* **13** *Museum of Natural History and Botanic Garden, University of Calabria, Loc. Polifunzionale, 87036 Arcavacata di Rende (Cosenza), Italy* **14** *Via V. Cerulli 59, 00143 Rome, Italy* **15** *Department of Earth Sciences, of Environment and Life, University of Genova, Corso Europa 26, 16132 Genova, Italy* **16** *Mediterranean Agronomic Institute of Bari, Via Ceglie, 9, 70010 Valenzano (Bari), Italy* **17** *Via Regazzoni Bassa 3, 35036 Montegrotto Terme (Padova), Italy* **18** *Via O. Coccanari 14, 00019 Villa Adriana, Tivoli (Rome), Italy* **19** *Department of Agriculture, University of Naples Federico II, Via Università 100, 80055 Portici (Naples), Italy* **20** *Department of Environmental Biological and Pharmaceutical Sciences and Technologies, University of Campania Luigi Vanvitelli, Via A. Vivaldi 43, 81100 Caserta, Italy* **21** *Department of Environmental Biology, Sapienza University of Rome, Piazzale A. Moro 5, 00185 Rome, Italy* **22** *Department of Biology, Ecology and Earth Science, University of Calabria, via P. Bucci, 87036 Arcavacata di Rende (Cosenza), Italy*

Corresponding author: *Daniela Bouvet* (daniela.bouvet@unito.it)

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Abstract

In 2014, the annual field trip of the working group for Floristics, Systematics, and Evolution of the Italian Botanical Society was held in Piemonte (northern Italy), at the head of the Po Valley. This valley, at whose extremity is located the Monviso (3,841 m a.s.l.), belongs to the Cottian Alps about which very little is known from a floristic point of view. An inventory of the taxa of vascular plants collected during the field trip is reported here. The research led to the identification of 3,546 *exsiccata*, kept in nine public and nine private collections. A total of 669 taxa belonging to 79 plant families were recorded. Six taxa resulted endemic to Italy and three exclusive to Piemonte, while only nine alien species were detected; six taxa are new and five confirmed for the regional flora.

Keywords

Cottian Alps, regional flora, new floristic records, vascular flora

Introduction

This contribution is part of the activities promoted by the working group for Floristics, Systematics, and Evolution of the Italian Botanical Society, which, since 2003, has given particular emphasis to territorial research aimed at floristic censuses, jointly conducted by botanists from different Administrative Regions. One of the main goals of the working group is to increase knowledge about the vascular flora of poorly known areas. Only three expeditions have been carried out so far in central and northern Italy, two in Liguria (Peccenini et al. 2007, 2010) and one in Toscana (Peruzzi et al. 2011).

In this paper, we present the results of a field trip held in 2014 in Piemonte (northern Italy), organized by Daniela Bouvet, Annalaura Pistarino and Adriano Soldano. The aim of the trip was to increase our floristic knowledge of the Po Valley on the Piemonte side of the Cottian Alps. The area that has been poorly studied from floristic and vegetational points of view (Bouvet et al. 2005), and the valley is considered an "area with intermediate floristic knowledge".

Study area

The area covered by the excursion is located in Piemonte at the head of the Po River basin; from an administrative point of view, it falls within the Cuneo province, in the municipalities of Ostana, Oncino and Crissolo and in a small part of Paesana (Fig. 1).

The Po Valley is geographically located between the Pellice Valley to the north and the Varaita Valley to the south and southwest, and borders to the west with the Guil Valley along the Italian-French cross-border waterfront ridge. The valley runs from southeast to northwest from the plain to Paesana and irregularly east-west in the middle-upper part; it is over 30 km long. The altitude ranges from 400 m a.s.l. at Revello-Martiniana Po to 3,841 m a.s.l. at the top of the Monviso, which surmounts the surrounding peaks by about 500 m (Suppl. material 1: 1).

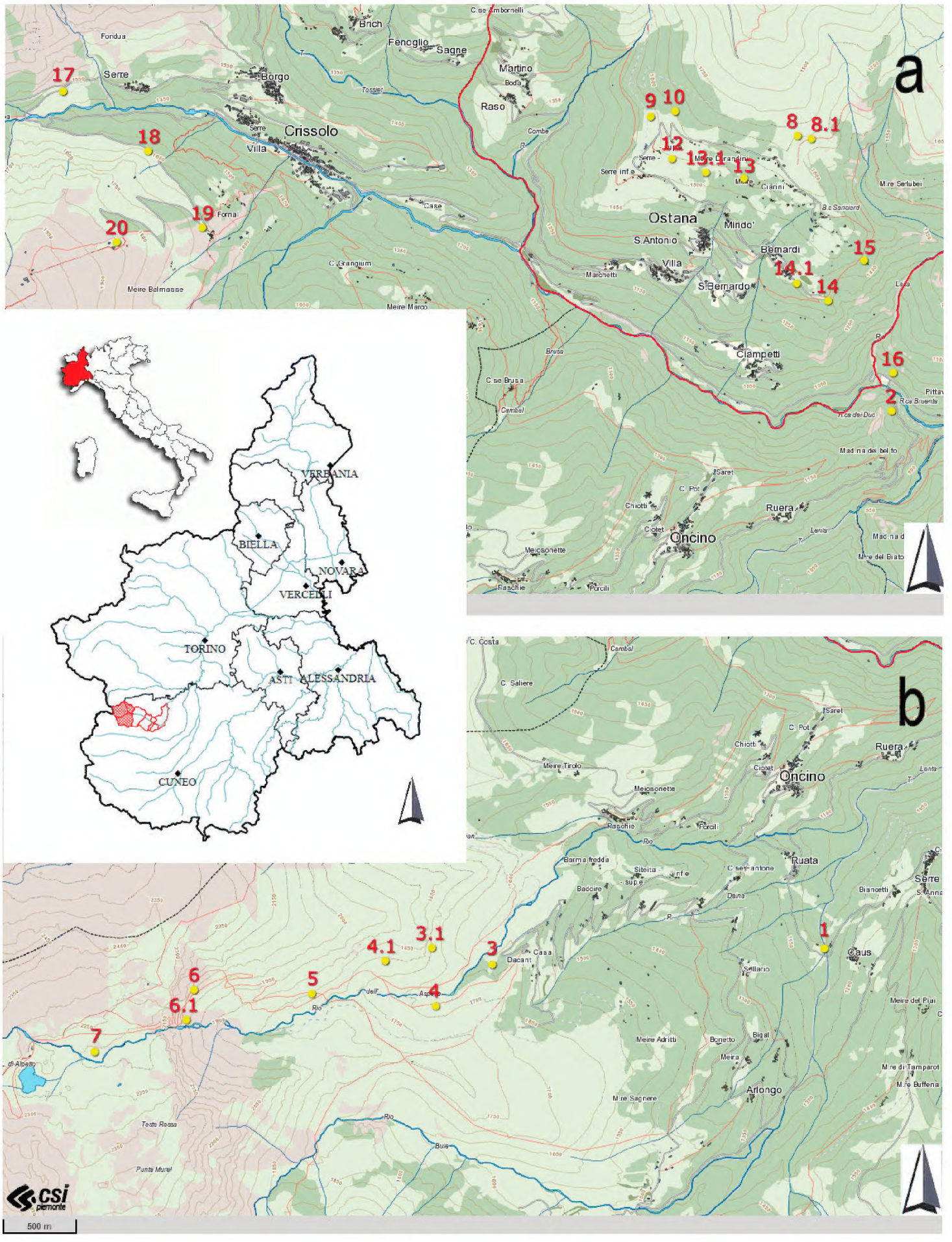

Figure 1. Area where the annual field trip of the working group for Floristics, Systematics and Evolution of the Italian Botanical Society took place and topographic maps (scale 1:20,000) with collecting sites (number and yellow dots). For detailed data of each site, see Suppl. material 1: 5. **a** July, 9 (site n. 2), July, 11 (from site n. 8 to n. 16), July, 12 (from site n. 17 to n. 20) **b** July, 9 (site n. 1) and July, 10 (from site n. 3 to n. 7). From: GeoPortale Piemonte (Regione Piemonte – http://www.geoportale.piemonte.it/).

The Po Valley is one of the historic cross-border trade routes. It was used in the Middle Ages, although less than the Varaita Valley; it connected the Marchesato of Saluzzo with the Château Queyras (in the Guil Valley, currently in the Département Hautes-Alpes), through the road from Revello, Sanfront and Paesana, where it joined the one from Barge, thereby connecting this area with the Pinerolese area and the domains of Savoy. In the past, the ancient pedestrian pass of the Po Valley was the Colle delle Traversette (2,950 m a.s.l.); the first alpine tunnel, the "Hole of the Viso" (2,882 m a.s.l.), a tunnel less than 100 m in length, was excavated in 1479–80 in order to allow trade with France.

The orography of the valley narrows upstream of Paesana, becoming steep and closed in the municipalities of Ostana, Oncino and Crissolo and widening in correspondence with the glacial plains of Pian della Regina and Pian del Re at the base of the Monviso. The natural and social environment is characterized by a remarkable heterogeneity, with settlements organized in small historically important mountainous hamlets, located between the valley floor and the lower mountain slopes. As in many western alpine valleys, the following phenomena occur:

- widespread abandonment and depopulation of the head of the valley, with small, more populated villages (e.g., Crissolo, Ostana, Oncino), and episodic congestion due mostly to summer tourism;
- abandonment of marginal areas (grassland-pastures) or impervious areas unsuitable for pasture, therefore with spontaneous re-naturalization through tree and shrub invasion and, at high altitudes, *via* herbaceous and suffruticose alpine formations, with a greater degree of wildness, but lower pabular value;
- abandonment of anthropogenic forests (chestnut) and progressive advancement of the senescence and forest instability phases;
- interventions on watercourses, especially on the Po River, with the creation of artificial banks and weirs at the head of the valley, mostly resulting in a loss of wildness.

The Western Alps are characterized by a high degree of geological complexity (Compagnoni and Sandrone 1981). In particular, the investigated area is located at the point of contact between two well-differentiated areas: at the head of the Po Valley near Ostana-Oncino, considering an imaginary north-south line from Villanova to Ostana, the Dora-Maira Massif to the east and the Piemonte Zone of calcschists with ophiolites to the west are placed side by side (Suppl. material 1: 2).

The Dora-Maira Massif is characterized by metamorphic rocks, of both eruptive and sedimentary origin, involved in alpine orogenesis. The most common lithological types are gneiss and micaschists and, in subordinate quantities, quartzites, marbles and amphibolites.

The Piemonte Zone consists of heterogeneous metamorphic rocks of sedimentary and eruptive origin, where three different sequences are distinguished by lithological composition: a predominantly triassic carbonate sequence, a jurassic carbonate-argillaceous sequence (calcschists) and a set of rocks linked to deep magmatic events

(ophiolites). The landscape of the calcschistous areas, due to the poor resistance of these rocks to atmospheric agents, is characterized by basically soft shapes, as opposed to the steep relief of green stones and limestone-dolomite walls.

The rocks of the Dora-Maira Massif and of the Piemonte Zone emerge in the area with discontinuities: in fact, they are often covered with incoherent materials, resulting from their mechanical removal and their chemical alteration on the surface environment. In cartography they are, generally, referred to as quaternary overlay, which includes morainic soils, alluvial and conoid deposits, debris and debris cones, and eluvio-colluvial overlay.

From a climatic point of view, based on annual rainfall distribution, the head of the Po Valley is characterized by a continental pluviometric regime with the lowest rainfall being in winter. Pluviometric data for the Paesana municipality tend to a prealpine regime, with a main rainfall peak in spring and a secondary one in autumn; data for the Crissolo municipality suggest a subalpine regime, with a main rainfall peak in autumn and a secondary one in spring. Average annual temperature and precipitation values correspond to Thornthwaite's humid climate for the municipality of Paesana (altitude 614 m) and to perhumid for the municipalities of Oncino (1,220 m), Ostana (1,250 m) and Crissolo (1,318 m) (Suppl. material 1: 3).

Part of the study area (e.g., the Alpetto Valley) is included in the "Parco naturale regionale del Monviso" (Monviso Regional Park) and in the ZSC "Gruppo del Monviso e Bosco dell'Alevé" (IT1160058), in continuity with the Parc Naturel Régional du Queyras on the French side. In 2013, the Monviso has become a MaB Reserve of UNESCO.

According to "Habitat Directive" 92/43/EEC, the biotopes of particular interest from a botanical standpoint, are the Pian del Re peat bog (included in the Special Natural Reserve of the Parco del Monviso), which retains peculiar glacial wrecks (Priority habitats 7240 *Alpine pioneer formations of *Caricion bicoloris-atrofuscae* and 7230 Alkaline fens), and the maple-lime-ash forests in the Oncino Valley (Priority Habitat 9180 **Tilio-Acerion* forests of slopes, screes and ravines).

There is no overall study that assembles the floristic studies conducted over the centuries in the Po Valley. Some punctual contributions have been published, mostly for high-altitude flora or for findings of interesting species, or for the conservation of protected areas.

Material and methods

During the four days of research (July 9–12, 2014), 34 participants to the field trip, accompanied by three foresters of the Monviso Regional Park (Suppl. material 1: 4) collected samples in 20 sites corresponding to biotopes considered significant for the head of the Po Valley. For each collecting site the reference number for the floristic list, collection date, toponyms with a short description, altitude, main habitats, cartographic coordinates (using UTM projection, ED50 geodetic system) and number of *exsiccata*

collected for each site are indicated (Suppl. material 1: 5). These collecting localities are related to litotypes of the substrates in Suppl. material 1: 2 and to a topographic map with a detail of 1:20,000 in Fig. 1.

In analogy with the working method already experienced in previous trips, the identification of *exsiccata* was carried out firstly individually by the collectors; then the most critical samples were revised by botanists present at a two-day meeting held on 23 and 24 February 2015 at the Department of Life Sciences and Systems Biology of the University of Turin. Specimens with no satisfactory identification yet were re-examined by some participants.

The floristic list was produced with the contribution of almost all participants to the field trip; some critical genera required the support of specialists: Ardenghi N.M.G. (*Festuca*, *Schedonorus*), Buccheri M., Casolo V. and Martini F. (*Achillea*), Cecchi L. (*Pulmonaria*), Domina G. (*Orobanche*), Dotti L. and Isaja A. (*Herminium*, *Nigritella*), Festi F. and Fröhner S.E. (*Alchemilla*), Gallo L. (*Hylotelephium*, *Sedum*, *Sempervivum*), Gottschlich G. (*Hieracium*, *Pilosella*), Marchetti D. (*Asplenium*, *Cystopteris*, *Dryopteris*), Martignoni M. (*Euphrasia*), Martinetto E. (*Cyperaceae*), Paiero P. (*Salix*), Polidori J.-L. (*Gentiana*), Scoppola A. (*Viola*), Selvaggi A. (*Juncus*, *Luzula*), Vogt R. (*Leucanthemum*) and Zaccara P. (*Pinguicula*).

Each systematic unit in the list is supported by at least one herbarium sample stored in either a public or private collection (Suppl. material 1: 6). Nomenclature and taxa delimitation followed the updated version of the Checklist of Italian Flora (Bartolucci et al. 2018, Galasso et al. 2018), except for varieties and hybrids (not considered in the above-mentioned Checklist).

In the floristic list (Suppl. material 1: 7), the systematic order and taxonomic circumscription of the families follow Bartolucci et al. (2018) and Galasso et al. (2018). Taxa are ordered alphabetically within each family. For each unit, synonyms used as accepted names in Conti et al. (2005, 2007) are indicated in square brackets. The reference number of the collecting site (Suppl. material 1: 5) and, in brackets, the herbarium collections in which the samples are kept, are reported below; when they belong to public collections, they are indicated with their acronym according to Thiers (2017), if part of a private collections with a code indicated in Suppl. material 1: 6.

The letter "E" preceding the scientific name indicates an endemic taxon for Italy (following Bartolucci et al. 2018); the letter "e" refers to few "exclusive" taxa, i.e., taxa that within Italy are only present in Piemonte, but are also present in neighbouring countries (France and/or Switzerland) (according to Bartolucci et al. 2018 and Aeschimann et al. 2004). The letter "A" indicates an alien unit; it is followed by the regional status: "NAT" for a naturalized species, "INV" for an invasive one (according to Bartolucci et al. 2018 and Galasso et al. 2018). The floristic novelties for the regional flora, according to Bartolucci et al. (2018) are marked with asterisks (** = new unit, * = confirmed unit, previously "Doubtful" or "Not Confirmed"). For some units that were particularly critical, a systematic, taxonomic and/or nomenclatural note has been included.

Results

During the field trip, almost 3700 samples of vascular plants were collected. The specimens identified at the species level are 3546. Amongst these, 594 specimens were collected in the first half-day of the excursion, 1691 in the second day, 957 in the third day and 304 in the fourth half-day. The site with the largest number of samples collected is by far No. 3 (443) (see the number of *exsiccata* for each site in Suppl. material 1: 5).

The specimens included in the floristic list belong to 669 taxa and 79 plant families (see Suppl. material 1: 7), including three varieties (*Thymus pulegioides* L. var. *pulegioides*, *Thymus pulegioides* var. *vestitus* [Lange] Jalas, *Laserpitium gallicum* subsp. *gallicum* var. *angustifolium* [L.] Lange) and one hybrid (*Carex lepidocarpa* Tausch × *Carex demissa* Hornem.).

Six taxa are endemic to Italy (indicated with "E" in Suppl. material 1: 7):

Sedum alsinifolium All.
Alchemilla vaccariana Buser
Dianthus furcatus subsp. *lereschii* (Burnat) Pignatti
Pulmonaria vallarsae subsp. *apennina* (Cristof. & Puppi) L.Cecchi & Selvi
Melampyrum italicum (Beauverd) Soó
Campanula elatines L.

Amongst these, two species are only present in Piemonte (*Campanula elatines* L. and *Sedum alsinifolium* All.), one only in Piemonte and Val d'Aosta (*Alchemilla vaccariana* Buser) and one only in Piemonte and Val d'Aosta and doubtfully in Liguria (*Dianthus furcatus* subsp. *lereschii* [Burnat] Pignatti).

Three taxa are exclusive to Piemonte, i.e., present in no other Administrative Region of Italy, but present in neighbouring countries (indicated with "e" in Suppl. material 1: 7):

Pulsatilla alpina subsp. *cottianaea* (Beauverd) D.M.Moser (endemic to the Western Alps, present in Piemonte and France), *Gentiana rostanii* Verl. (endemic to the Western Alps, present in Piemonte and France), *Hieracium piliferum* subsp. *subnivale* (Gren. & Godr.) Zahn (endemic to south-west Europe, present in Piemonte and France).

Only nine alien species were found.

Four of them are considered invasive in Piemonte (indicated with "A INV" in Suppl. material 1: 7): *Juncus tenuis* Willd., *Robinia pseudacacia* L., *Erigeron annuus* (L.) Desf. and *Galinsoga quadriradiata* Ruiz & Pav.

Five are considered naturalized (indicated with "A NAT" in Suppl. material 1: 7): *Papaver argemone* L. subsp. *argemone*, *Oxalis stricta* L., *Digitalis purpurea* L. (spontaneous in Calabria and Sardegna), *Veronica persica* Poir. and *Matricaria discoidea* DC.

Six taxa are floristic novelties for the regional flora of Piemonte (indicated with "**" in Suppl. material 1: 7):

Melica transsilvanica subsp. *klokovii* Tzvelev
Saxifraga cuneifolia subsp. *robusta* D.A.Webb

Alchemilla transiens (Buser) Buser
Salix waldsteiniana Willd.
Tilia platyphyllos subsp. *cordifolia* (Besser) C.K.Schneid.
Taraxacum panalpinum Soest

Three taxa were considered "doubtful" in Piemonte and are thus confirmed (indicated with "*" in Suppl. material 1: 7):

Helictochloa praeusta subsp. *pseudoviolacea* (Dalla Torre) H.Scholz
Cuscuta planiflora Ten.
Picris hieracioides L. subsp. *umbellata* (Schrank) Ces.

The finding of two species, for which the specimens collected in the Po Valley are the first since over 50 years, confirms the presence of the entity in Piemonte (indicated with "*" in Suppl. material 1: 7):

Centaurea scabiosa subsp. *alpestris* (Hegetschw.) Nyman
Leucanthemum ircutianum DC. s.l.

A significant number of collected taxa are included in Red Lists (the category of risk is indicated in brackets):

– seven species are included in the Red List of Piemonte (Conti et al. 1997):

Carex fimbriata Schkuhr (LR, also included in the Italian Red List)
Aquilegia alpina L. (LR)
Sedum alsinifolium All. (LR)
Malva moschata L. (LR)
Noccaea sylvia (Gaudin) F.K.Mey. (LR, also included in the Italian Red List)
Drosera rotundifolia L. (VU)
Cerastium lineare All. (LR, also included in the Italian Red List)

– eight taxa are included in the IUCN Red List of the Italian Flora (Rossi et al. 2013):

Huperzia selago (L.) Bernh. ex Schrank & Mart. subsp. *selago* (Least Concern)
Lycopodium clavatum L. (Least Concern)
Selaginella helvetica (L.) Spring (Least Concern)
Selaginella selaginoides (L.) Schrank & Mart. (Least Concern)
Herminium monorchis (L.) R.Br. (Endangered)
Aquilegia alpina L. (Least Concern)
Gentiana lutea L. subsp. *lutea* (Near Threatened)
Arnica montana L. subsp. *montana* (Least Concern).

A number of units were not identified at a detailed level: one taxon was identified at the section level (*Taraxacum* sect. *Alpina* G.E.Haglund), 20 species were identified *sensu lato* (*Viola calcarata* L., *Buphthalmum salicifolium* L., *Hieracium bifidum* Hornem., *H. dasytrichum* Arv.-Touv., *H. dentatum* Hoppe, *H. glaucinum* Jord., *H. lachenalii* Suter, *H. murorum* L., *H. obscuratum* Murr, *H. pilosum* Froel., *H. ramosissimum* Hegetschw., *H. scorzonerifolium* Vill., *H. tenuiflorum* Arv.-Touv., *H. valdepilosum* Vill., *H. villosum* Jacq., *Leucanthemum coronopifolium* Vill., *Leucanthemum ircutianum* DC., *Pilosella lactucella* [Wallr.] P.D.Sell & C.West, *P. piloselloides* [Vill.] Soják, *Scabiosa columbaria* L.).

Eight taxa were not identified with certainty and, therefore, are not included in the floristic list (*Festuca plonkae* Foggi & Signorini, *Alchemilla chirophylla* Buser, *A. incisa* Buser, *Urtica dioica* L. subsp. *pubescens* [Ledeb.] Domin, *Hypericum* ×*desetangsii* Lamotte, *Erysimum jugicola* Jord., *Pinguicula reichenbachiana* Schindl., *Leucanthemum heterophyllum* [Willd.] DC.).

Discussion

The 669 taxa found in the study area represent ca. 17% of the flora of Piemonte (4015 taxa, according to Bartolucci et al. 2018 and Galasso et al. 2018); they were found over an area that represents only 0.4% of the Regional area (the Crissolo, Oncino and Ostana municipalities occupy a surface area of 113 km^2, out of the 25,387 km^2 of the total).

Endemics (six) amount to almost 0.9% of the taxa observed and to 3.8% of the endemic species present in Piemonte (158, according to Bartolucci et al. 2018).

The percentage of alien species is very low (1.3%), compared with the percentage (12.8%) reported by Galasso et al. (2018), probably due to the altitude of the collection sites (always above 900 m) and to the relative low rate of anthropization of the habitats explored. This low percentage reveals that the area includes environments with a high degree of wildness.

Overall, there are six new taxa for the flora of Piemonte and five confirmations of doubtful or not confirmed taxa.

The high number of species detected, even in a few days of collection and in a small number of sites, suggests that the diversity of the flora in this area is remarkable and deserves further research. In particular, the Alpetto Valley and the surroundings of Ostana were unknown from a floristic point of view. The collected data also contribute to drafting the naturalistic plan of the "Parco del Monviso" and provide useful data for monitoring habitats and species of European interest (as required by Habitat Directive 92/43/EEC).

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Supplementary material 1

Supplementary data

Authors: Daniela Bouvet, Annalaura Pistarino, Adriano Soldano, Enrico Banfi, Massimo Barbo, Fabrizio Bartolucci, Maurizio Bovio, Laura Cancellieri, Fabio Conti, Romeo Di Pietro, Francesco Faraoni, Simonetta Fascetti, Gabriele Galasso, Carmen Gangale, Edda Lattanzi, Simonetta Peccenini, Enrico Vito Perrino, Roberto Rizzieri Masin, Vito Antonio Romano, Leonardo Rosati, Giovanni Salerno, Adriano Stinca, Agnese Tilia, Dimitar Uzunov

Data type: Word .doc file

Explanation note:

1. Monviso and the head of Po Valley.

2. Collection sites displayed on the Geological map of Italy (scale 1:100,000). For detailed code of each site see Suppl. material 1: 5.

3.1. Temperature and rainfall data for the weather station of Paesana (1,265 m a.s.l.) in the period 1993–2017.

3.2. Temperature and rainfall data for the weather station of Crissolo (1,342 m a.s.l.) in the period 2012–2017.

3.3. Snowfall data for the weather stations of Paesana (1,265 m a.s.l.) and Pian Giasset (2,150 m a.s.l.) in the period 2002–2017.

4. The 34 participants to the field trip of the working group for Floristics, Systematics and Evolution of the Italian Botanical Society from 9 to 12 July 2014.

5. List of collecting sites, with reference number, date of collection, placename with short description, altitude, main habitats, cartographic coordinates (expressed using UTM projection, ED50 geodetic system, zone 32T), number of *exsiccata* collected for each site. For detailed topographic map see figure 1.

6. Public *herbaria* and private collections in which the *exsiccata* collected are kept. Acronyms of public collections refer to Thiers (2017); in the column on the right number of *exsiccata* kept in each collection.

7. Floristic list of taxa observed at the head of the Po Valley (Piemonte, province of Cuneo) with reference number of collecting site and *herbaria* collections (in brackets). For detailed code of each site and *herbaria* see Suppl. material 1: 5, 6.

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